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DOCTRINES HELD AS VITALISM

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1. A well-known zoologist remarks that before certain papers had elucidated vitalism, he had had a personal meaning for the word, but after, he did not know at all what vitalism means.[1] Are not many of us in this case? And is not the remedy more papers on vitalism, such as we have recently had from Lovejoy, Ritter, Glaser, Woodruff, MacDougall and others—in order that we may know what is in each other's minds? In the obscurity, persons holding the same views are rallying to different battle cries, while those with diverse views march in supposed alliance. The following has arisen in the course of an attempt by the writer to clear his own mind on the matter, and particularly to discover for practical purposes whether the principles underlying the work of the biologist are essentially diverse from those of the rest of science.

The papers of Lovejoy[2] have been of the greatest value in distinguishing and classifying the views commonly held as vitalism, but there appear to be still certain important distinctions that need emphasis before the obscurity is quite dissipated.

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[1] "V. L. K.," in *Science,* October 20, 1911, p. 520.

[2] *Science,* November 26, 1909; April 21, 1911; July 21, 1911; November 15, 1912.

TWO DIVERSE GENERAL CLASSES OF VITALISTIC DOCTRINE

2. Two fundamentally diverse questions are dealt with in discussions of vitalism, often as if they were the same. The two questions bear respectively upon (*A*) the need for the division of science into two contrasted parts; and (*B*) the nature of science.

A. The doctrine perhaps most commonly signified by vitalism is that there is a deep-lying distinction of some sort between what occurs in the living, and what occurs in the non-living; with a correlative deep-lying distinction between the sciences that deal with the two; so that science must on this account be divided into two kinds, vitalistic and non-vitalistic.

B. Vitalism is sometimes used to signify merely the doctrine that mechanistic formulation is not adequate for giving an account of nature. In place of it there must then be put some other formulation, and this is at times called vitalistic. The clearest statement I have found of this is given by Rádl:

> One either banishes completely the idea of causality from science, or one distributes it in quantitative elements present everywhere, whose origin one holds not to be open to investigation; or one conceives the elements to be qualitative entities. The first view leads to geometry, the second to mechanism, the third to vitalism.[3]

3. It is clear that this "vitalism" *B* is the doctrine held for physics and chemistry under the name of "energetics" by such men as Ostwald. It is not presented by Rádl as characterizing a difference between the living and the non-living; it merely holds that science is necessarily non-mechanistic. It would be equally valid if there were no living things as objects of study.

4. Lack of clear distinction as to which of these two doctrines is meant by vitalism results in discussion at cross-purposes, one party dealing with the doctrine *A*, the other with *B*. Not infrequently indeed the two questions appear to be confused in the mind of a single

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[3] Translation from Rádl, "Geschichte der Biologischen Theorien," Bd. 1, p. 81.

thinker, the grounds he gives for vitalism tending merely to show that nature can not be explained mechanically, while the conclusion he draws is that there is a distinction between the living and the non-living; though he may also hold that the non-living can not be explained mechanically. In this way it is evident that no difference in principle is made between the living and non-living.[4]

5. To clear up this matter one may propose to himself the following:

Test Question.—Suppose it were demonstrated that mechanical formulation[5] is not adequate for living things, would that establish vitalism, *without a correlative demonstration that it is adequate for non-living things?*

If one answers this question affirmatively, his vitalism is of the class *B*, not requiring any difference in principle between the living and the non-living.

6. My own "personal meaning" for vitalism had been that set forth under *A;* I had supposed it an irreducible minimum for a vitalistic doctrine that it should make a deep-lying distinction of some sort between the science of the living and that of the non-living; but the arguments for vitalism adduced by various authors show that not all share this idea. It appears clear that the doctrine *B,* that mechanism is not adequate to nature in general, has no distinctive interest for the biologist; he shares his interest in such a question on an equal footing, theoretical and practical, with the physicist. Many persons who do not call themselves vitalists hold that the mechanical formulation of nature (as simply masses moving in space and time, and the laws of such movements, with nothing

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[4] A grosser form of the same confusion is at times seen in the proposition that science can not "explain" life. These statements as a rule imply such a meaning of the word *explain* that it is equally true that science can explain nothing whatever—so that again no distinction is made between the living and the non-livng. See the excellent development of this point by Glaser, *Pop. Sci. Monthly,* July, 1912.

[5] For our purposes it is immaterial just what is understood by mechanical formulation, provided the meaning is the same when applied to the living as when applied to the non-living.

else) has not demonstrated itself adequate for nature, organic or inorganic; and perhaps incline to the view that it will be shown inadequate. Such, for example, is the position taken by Bütschli, in what he considers to be an attack on vitalism,[6] such also is the position of the present writer. "Vitalists" that hold to nothing more than this will avoid classification with a totally different set of theorists if they pronounce themselves clearly on this question; and the same is true for "non-vitalists." Do you or do you not hold that there is a deep-lying distinction between the science of the living and that of the non-living? Do you hold that mechanism is or is not adequate to nature? These questions are not identical.

VITALISM AS THE DOCTRINE THAT THERE IS A DEEP-LYING DISTINCTION BETWEEN THE SCIENCE OF THE LIVING AND THAT OF THE NON-LIVING

7. Leaving aside such "vitalism" as is merely a general alternative to "mechanism," and understanding by it the doctrine that there is a deep-lying distinction between the occurrences in the living and those in the non-living (which I believe is the idea that at least lurks in the background in most minds, even though the grounds discussed may not directly bear upon it)—then its validity is open to the following:

8. *Test.—Examination to determine whether the characteristics of living things, or of the science of living things, that are urged as ground for vitalism, are really distinctive of the living, as contrasted with the non-living. If both living and non-living are found to possess them, these characteristics furnish no ground for vitalism.*

Much clearing of the atmosphere would result if we could so much as get a general expression of opinion as to whether this is a valid test. In the following I propose to examine by the aid of this test the common vitalism of class *A*. Different grounds may be urged, and have been urged, for making a deep-lying distinction between the living and non-living; we shall take up the main classes of these.

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[6] Bütschli, O., "Mechanismus und Vitalismus," Leipzig, 1901, pp. 7–8.

"Descriptive" Vitalism

D. 9. Descriptive and more or less superficial differences of course exist between the living and the non-living; this is the basis for distinguishing "biology" from "physics" or "geology." The question of vitalism is, whether there are deeper lying distinctions than those so expressed, such as to require the division of science into two contrasted parts, vitalistic and non-vitalistic. Many distinctions may be admitted to exist, and to be of interest, without their being considered ground for such a division of science.

10. It is of course difficult or impossible to state *a priori* what sort of a difference would be sufficient ground for holding science divisible into two contrasted parts. The following seem to be fair propositions: (1) The burden of showing that there exists a difference of sufficient depth to require the division of science into two contrasted parts is upon those that make the positive claim that there *is* such a difference; (2) the difference must be one as to the nature and laws of the *occurrences* in the two fields.

11. The most plausible descriptive ground for vitalism would be that which maintained that since living things have consciousness, while others, so far as we know, do not, we have here, *eo ipso*, a deep-lying difference between the two fields; and this quite independently of the question whether the activities of living things require consciousness for their explanation. Besides the impossibility of demonstrating the presence of consciousness in living things generally, and its absence in the non-living, such vitalism appears quite sterile, since all that it would express is now expressed by using the word consciousness.

Quite a different matter would be the contention that the fact of consciousness in organisms requires us to use in accounting for their activities different principles from those employed in the inorganic; this comes up at a later point.

12. Other descriptive differences are sometimes urged, such as the fact that only among living things exist bodies that have both individualized forms and complex structure. Few, however, consider such differences to actually constitute ground for vitalism, though they may be held to serve as indices to other differences, that do constitute such ground. Such essential differences fall in one of the two classes, *E* and *F*, set forth in following paragraphs:

VITALISM BASED ON THE OCCURRENCES IN LIVING THINGS

13. The differences in *occurrences* that are seriously proposed as a basis for distinguishing vitalistic from physical science appear to fall into two general classes:

E. Vitalism based in some way on the appearance of new laws of action in living things, although these new modes of action depend experimentally on the perceptual[7] conditions there found.

F. Vitalism based on the doctrine that the activity of some non-perceptual[7] agent must be considered in accounting for what occurs in living things, so that the perceptual conditions alone do not furnish unequivocal determining factors for what occurs ("experimental indeterminism").

14. It may aid in understanding the drift of what follows to state first the conclusion to which the analysis comes. This conclusion is that theories of the sort mentioned under *E* do not make any valid distinction between the science of the living and that of the non-living, even

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[7] By perceptual or physical condition is meant any condition which could be detected by any sort of physical tests, *beyond the single effect from which its presence is first assumed.* This point is analyzed in detail in my paper in *Science* of June 16, 1911.

if we admit that what they state for the living is correct; this conclusion results from a consideration of the nature and method of science. Those mentioned under *F*, on the other hand, if admitted for living things, make a real difference of fundamental character between the two fields (unless we admit experimental indeterminism for the non-living also).

E. VITALISM BASED ON NEW LAWS OF ACTION IN LIVING THINGS

15. This "doctrine of organic autonomy"[8] is well expressed by Lovejoy as follows:

> What the vitalist maintains is that, even given a complete knowledge *both* of all the laws of motion of inorganic particles and of the actual configuration of the particles composing a given body at a given cross-section of time, you could not from such knowledge deduce what the motion of the particles, and the consequent action of the living body, would be.

Lovejoy later continues:

> Again, such a view would not, in itself, deny that the behavior of organisms is a function of the number and configuration of the material particles composing them.[8]

16. Now, with regard to all theories fulfilling these conditions, the essential question is as follows:

Even if it be granted that under the conditions found in living things, the laws of action are diverse from those observable in the non-living, does the science of living things therefore bear a relation to the rest of science differing from that borne by the parts of inorganic science to each other? Or would this be merely one example, out of many, that from a knowledge of what happens under given conditions, it is frequently not possible to predict what will happen under other conditions?

17. An affirmative answer to this latter question will take away the ground for dividing science into two divisions, vitalistic and non-vitalistic, on such a basis. In the following it is proposed to examine the main sup-

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[8] *Science*, April 21, 1911.

posed grounds for vitalism falling under E, to discover whether they do make distinctions between the sciences of the living and the non-living that are essentially diverse from the internal differentiations of inorganic science.

The answer to this question will depend to a certain extent at least upon one's views as to the nature and method of progress in science; the way scientific generalizations ("laws") are reached. The questions of vitalism come back so directly to this that the best method of exposition will be to take up the nature and method of science explicitly.

18. *Formulation of the Work of Science.*—To understand the nature of science it is necessary to look at it in process of formation: to consider the condition of affairs before a given part of science is formulated, and to observe how the formulation occurs. To look upon science as something done and fixed, in order to grasp its character, is most misleading. Yet it is not uncommon. Bergson says, for example, that we necessarily treat the living like the inert, "carrying over into this new field the same habits that have succeeded so well in the old; and it is right to do so."[9] But if we look on science as *forming* habits (rather than as exclusively a thing with habits formed), there will appear no reason why it should not have the same direct and original relation to the living as to the non-living, forming its habits on the former as well as on the latter.

19. Viewing the matter in this way, we may say that science is a name for humanity's process of making a survey of the universe, with an attempt to formulate the results of this survey. So far as it deals with occurrences, we may say that it is an attempt to determine the conditions under which things happen. So far as it formulates its results, it gives "a series of propositions asserting what under given conditions our experience

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[9] "Creative Evolution," p. 195.

would be.''[10] Or, since all ''conditions,'' so far as we can deal with them, are experiences, what science tries to formulate reduces to propositions of the following form:

''When you have such and such experiences, you will have such and such other experiences.''[11]

Thus science is a process of getting varied experiences, including the experience of discovering how diverse experiences are interconnected, and of formulating these experiences, particularly the interconnections.

20. Generalizations, laws, are formulations, of the sort characterized above, that cover many experiences or things at once. The possibility of generalizations depends upon the fact that things which differ in some respects may be (or act) alike in other respects. This is what makes science as a system possible. Everything distinguishable is unique in some respect; otherwise, it would not be distinguishable; it differs at least in place or in time, and so in its relation to the rest of the configuration of the universe, from everything else. But it is found that certain of the differences between things do not affect certain of their properties or actions, so that we do find uniformities in nature. The study of how things or processes are determined is largely a study of what antecedent differences do, what do not, alter the particular succeeding difference in which we are interested; or just what succeeding differences they do make. But *whether a given diversity does affect a given property or action is determinable, in the first instance, only by experience.*

21. *Interruption of the Exposition in Order to Make the Application of this Point to Certain Doctrines Proposed as Vitalistic.*—The fact that two things which differ in some respects act alike in some respects is certainly nothing peculiar to living things. On this ground I can not see anything vitalistic in any sense, in one of

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[10] Balfour, ''Defense of Philosophic Doubt,'' p. 181.

[11] This formulation of what science tries to do leaves quite open the underlying question of how it happens that we should have the experiences we do, and so appears to be valid whatever one's metaphysics.

the so-called vitalistic doctrines set forth by Lovejoy. This doctrine Lovejoy characterizes as follows:

> There is, however, a doctrine which goes beyond this mere assertion of organic autonomy, and declares that (in part) the action of living bodies *is not strictly a function of the number and spatial configuration of the particles composing them at any given instant.* In other words, organisms not only have unique laws of their own, but these laws can not even be stated in terms of the number and arrangement of the organism's physical components.[12]
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> It is the doctrine that certain vital phenomena are not dependent upon "any fixed configuration of material parts existing in the organism or cell at the moments at which the phenomena take place"—*i. e.,* that the same phenomena occur in a given organism in spite of profound modifications of the composition and configuration of the parts, through a sort of redivision of labor and redistribution of functions among the parts that remain.[13]

22. In a former paper[14] I interpreted the proposition quoted above, that the laws of organisms "can not even be stated in terms of the number and arrangement of the organism's physical components," as a statement of Driesch's view, that the organism's physical components fail to include the factors necessary for the determination of the diversities that occur, so that the same set of perceptual components may act in different ways at different times (as determined, according to Driesch, by a non-perceptual factor), thus giving experimental indeterminism. It appears, however, from the discussion in Lovejoy's later papers[15] that he meant merely the fact "that the same phenomena occur in a given organism in spite of profound modifications of the composition and configuration of the parts." But this can be asserted equally as a positive fact for both living and non-living. With this interpretation we could in the first of the two statements quoted above substitute "bodies" for "living bodies," and have a proposition that holds for things in general. An iron body of a certain form moves toward the earth. We may change the form in most

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[12] Lovejoy, *Science,* April 21, 1911. Italics in original.

[13] Lovejoy, *Science,* July 21, 1911.

[14] *Science,* June 16, 1911.

[15] *Science,* July 21, 1911, and November 15, 1912.

varied ways; it still moves toward the earth. We may change the material, substituting lead, brass, stone, wood; it still moves toward the earth. We may change both form and material in most radical ways; it still moves toward the earth. In a clock that keeps time we may substitute iron wheels for brass ones; we may remove a number of the wheels, and substitute others in different number and form and made of different material, and still have the clock keep time. A stream that flows to the sea will still flow to the sea though its bed be altered in many ways; if obstacles are interposed, it will dig beneath, or overflow, or go around, or carry the obstacle away, and finally reach the sea. A microscope bringing light to a focus may be made of lenses of different materials, in different forms, in different arrangements. A diffraction grating may be substituted for a prism, in order to separate the rays of light of different velocities.

23. In all these cases it is evident: (1) that the particular changes made are such as do not affect radically the particular action in question; (2) we *could* make changes that *would* alter this action; (3) furthermore, in most cases at least, the process gone through does differ in certain respects after the change is made, although the general result remains the same. Now, precisely these same three statements can be made for the phenomena in organisms. When we remove a part of the egg of the sea urchin, or otherwise alter it, and it continues to develop, it is evident (1) that the change made is one that does not radically affect the development; this is a mere statement of the observed facts. But (2) we can readily make an alteration that will prevent the characteristic action, just as we can in the clock. No one, of course, denies this: all that is necessary is to remove the nucleus, or destroy its characteristic structure; and other changes will accomplish the same result. Again, (3) the processes after the egg has been altered are somewhat different from what they were before (as no one denies), though the development takes in its main features the

same course as before. The parallel appears to be complete between what happens when the organism is changed in ways not essential to its characteristic action, and what happens when the same thing is done for an inorganic combination.

24. I therefore quite agree with Lovejoy that when so interpreted "it is surprising that this, of itself, should be regarded as violating the rule of causal uniformity."[16] It appears equally surprising that it should be regarded as exemplifying something not common in the inorganic. To formulate the laws of what happens "in terms of the number and arrangement of the physical components" requires, for organic and inorganic equally, that we should recall that different sets of physical components often give the same laws (at least in main features); and the scientific procedure, in both fields, is to determine experimentally what alterations do, what do not, make a difference in the particular feature in which we are interested. Such an experimental analysis is (in large measure at least) equally practicable in the non-living and the living, and it has been successfully carried far in the latter. I therefore do not see how vitalism of any kind can be based on this state of affairs.

25. The vitalism of Driesch is based, not on the general principle, as interpreted above, but upon certain very special conditions which he believes can be demonstrated to exist in organisms, and which, *in their special nature,* render it impossible that the organism should continue to act in the "normal" way after division, except as some non-perceptual agent of a peculiar character acts as a determining factor. The concrete reasoning leading to this view is summarized in section 42 of the present paper.

26. *Resumption of the Exposition of the Work of Science.*—After we have had certain experiences of things and their interconnections, we can use these in prediction; indeed, the formulated scientific statement is in most

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[16] Lovejoy, *Science,* July 21, 1911.

cases essentially a prediction, for it says that if you get one set of experiences, you will have another also. But the prediction is made on the basis of experience already had. It could not be predicted without experience that the union of C, H and O in certain proportions will give the characteristic properties of the alcohols. There is no *a priori* reason that can be given for the appearance, in the first instance, of these characteristics. Yet we can use the experienced fact that they do appear in further prediction or explanation of what occurs under certain conditions. We learn by experience in the alcohol series what effect is produced by adding certain radicals; *after this* we can predict what effect such addition will have, *provided other conditions do not alter the case.* Whether any given set of the other conditions will alter the case can again be determined, in the first instance, only by experience.

This is certainly typical for the actual process of building up a large part of science. For such parts the fact of special importance here is the one last stated: *Whether any given change in the conditions will alter the action can be determined, in the first instance, only by experience.* This is exemplified in multitudes of instances by physical science, especially in the cases of "critical points." By numerous observations it is determined what progressive change in the properties of a substance is made by a certain amount of change in some condition, as temperature. A general law can be deduced which, since it works regularly so far as observed, would naturally be extended to include changes in parts of the scale not observed. But this would give false results, for at a certain point the characteristics suddenly change, becoming totally diverse from what they were, as in solidifying or vaporizing. Such sudden changes are most marked in chemistry. We have two substances mixed together, as H and O. We observe and formulate the changes they undergo as certain conditions are gradually changed. But at a certain point in this gradual change of conditions, the characteristics of the two substances alter radically, in a way quite diverse from that which our formulation hitherto has given us; in place of the two gases H and O there appears, for example, water. The science of chemistry deals with multitudes of these sudden changes, which are quite out of line with what is observed before precisely the necessary conditions are reached for producing them.

27. Now, among the things which have to be learned empirically are the effects of *configurations.* This is true even on the most strictly mechanistic view. The laws of the motion of a body when the configuration is such that forces from two other bodies act upon it at right angles had to be learned by experience, before they could be used in prediction. By varying the position of the bodies, the angles of the directions of the forces, the number of bodies or forces, etc., the laws of such variations were worked out, till now we have an extensive system that can be used in prediction. In chemistry we have a set of rules as to the effects of configuration that are not apparently continuous with the rules obtained in the way just set forth; the rules for the results when H and O are in one combination or another; when C, H and O, are in one configuration or another, had to be learned by experience in each case. We have thus in this direction a large store of propositions regarding configurations, that may be used in prediction. But for what will happen under any configuration never before experienced the only test is experience. It would have been quite impossible, for example, from a knowledge of what happens in the configurations given by the compounds of copper to predict the laws for the configurations given by compounds of carbon.

28. *Application to the "Doctrine of Organic Autonomy."*—This asserts, as we have seen, that with a knowledge of "all the laws of motion of inorganic particles and of the actual configuration of the particles compos-

ing a living body," one could not deduce the action of the living body.

Now, the configurations in living things are either the same as those in the non-living or they are different. If they, and all other conditions, are the same, and yet we get different results from them, then the uniformity of nature fails, and we drop into indeterminism. On the other hand, if they are different, then according to precisely the principles and practise of inorganic science, this different configuration is a matter whose consequences are to be learned only by experience. After it has been learned by experience it is a datum to be employed in prediction, exactly as are the corresponding data of inorganic science. The process of acquiring and using the knowledge is the same as that employed throughout the rest of science. To divide science into two divisions because the processes are the same in the two appears contrary to reason.

29. The thing that would show that the occurrences proceed on different principles in the two cases would be to discover that the *same combinations* acted differently in the two fields, for the fact that things in one configuration do not behave as they do in another is illustrated thoroughout inorganic science. The arguments for vitalism appear to lead, if maintained in a form such as to show a real difference in principle between living and non-living, almost always thus directly to indeterminism.

30. The strict mechanical theory holds that when we have gained an acquaintance with the elementary particles and with certain of the laws of their movements, combinations and interactions, we have experienced in principle everything that may occur, so that anything else which occurs can be expressed in terms of what we have already discovered. Thus, if we could be informed of the nature of the elementary particles and of their configuration in a living body, we could predict its action without acquiring further empirical knowledge.

31. But suppose that we discovered and could demon-

strate that in some of the configurations shown by living things, the particles move differently from their movements in the configurations dealt with hitherto in mechanics. This would simply show that the theory was in error which held that all possible effectively different configurations had in principle been experienced. It would leave us in the same condition that science would have been in if men had tried to predict the results of all configurations before the effects produced when two forces act at right angles had been experienced. To make the experience fuller, so that prediction would be possible, would require merely the extension of the same process used in getting the fundamental data of mechanics. The fact that some men supposed that they had gotten all the possible different sorts of experience when they had not seems no ground for dividing science into two contrasted parts; particularly when the second supposed part is built by a continuation of the process that produced the first.

32. While the considerations just set forth appear the decisive ones, certain other points may be noticed. The mechanical theory that from our knowledge of inorganic particles, their combinations and movements, we could predict behavior under all conditions that can be stated is one that, as matter of fact, can not be verified either for the inorganic or the organic. It may be held that perhaps the reason for this is that we do not yet know the conditions accurately enough to apply the laws of mechanics. But this answer can be given with equal force for the organic and the inorganic. To make exceptions to the mechanical theory largely destroys its *raison d'être;* for it is commonly held, not because it can be demonstrated, but because it furnishes a theoretically universal formula. If we fall back on the empirical evidence, we find difficulties of exactly the same character in applying the mechanical view to chemistry as to biology. There appears in the evident fact that the mechanical theory is as yet equally inadequate in the two fields

no ground for making a fundamental distinction between them.

33. A very subordinate additional possible ground for vitalism may be mentioned here. It may be held that combinations which have in fact never been produced before are frequently appearing in living things. This idea seems possibly in part the basis of Bergson's vitalism. Owing to the almost infinite number of variable factors involved in biological processes, it appears not improbable that this state of affairs actually holds. This might make it quite impossible to predict some of the things that will occur in biology, even with a knowledge of everything that had gone before; since the only test for what a new configuration will produce is experience. Does this constitute a basis for division of science into vitalistic and non-vitalistic? Apparently not. Suppose that a given previously unpredictable thing occurs, as a result of a configuration that had not before been realized. Suppose this be therefore accounted a vitalistic process. Now, suppose that after the lapse of time the same configuration recurs, and thus the same thing happens. It would now be no longer vitalistic. But the mere difference between a process that occurs once and the same process if it occurs again can hardly be considered sufficient for separating science into two divisions differing in fundamental principles. Just how many times a thing occurs seems rather irrelevant to the nature of the process, or to the nature of the science with which it deals.

On the other hand, if the same combination later recurred and did not give the same results, then indeed would we have a new principle involved; at the same time we should have to follow Bergson into indeterminism, the natural terminus of vitalistic theories.

34. *Psycho-vitalism and Finalistic Vitalism.*—These two doctrines differ, but for our present purposes they may be dealt with together. The former holds that the fact of consciousness in organisms requires us to use dif-

ferent principles for explaining what occurs in them from those employed in the inorganic; maintaining that in explaining movements consciousness must be substituted on the same footing of effectiveness for physical determining factors. Finalistic vitalism makes a similar claim for the employment of the end or purpose of a process, in explaining what happens.

In regard to both these doctrines, it appears that we are confronted with the same dilemma that we meet in other cases. Either for all diversities in physical action we can find antecedent physical diversities which are uniformly connected with the succeeding ones, so as to furnish a causal explanation for the latter, or we can not. In the former case a complete account or explanation of the processes can be given on the same principles as in all experimental science, so that there is no ground for separating off these processes in a special division of science. In the latter case we fall again into physical and experimental indeterminism; from the same physical conditions diverse physical results may follow, depending upon diversities in some factor not physical. This I should admit to be valid vitalism; it illustrates the way a vitalistic argument appears to wind up almost inevitably at experimental indeterminism.

F. VITALISM BASED ON THE DOCTRINE THAT A NON-PERCEPTUAL AGENT TAKES AN ACTIVE PART IN THE PROCESSES IN LIVING THINGS, ALTERING WHAT THE PERCEPTUAL CONDITIONS ALONE WOULD PRODUCE

35. The doctrine that a non-perceptual vital agent (as consciousness, purpose, entelechy) actively intervenes in the processes of organisms is at once the archetype and culmination of vitalistic doctrine; the one fully worked out exemplar of this type is the system of Driesch.

36. My analysis leads me to agree fully with Driesch that only by such active or dynamic vitalism is a real difference in principle made between the science of the oc-

currences in organisms and that for the inorganic. The change of Driesch's views on this point is worth sketching, as the type of the logical development of an attempt to establish a valid difference in principle between the living and the non-living. Driesch's earlier attempts in this direction (in his "Die Biologie als selbständige Grundwissenschaft" (1893), and the "Analytische Theorie der Organischen Entwicklung" (1894)), consisted in the advocacy of a "static teleology" for development; holding that purposiveness is shown, but this is "given" in the original structure of the egg, as that of a machine may be said to be given in its structure. But for the detailed analysis of the changes that occur, in the egg as in the machine, he held that perceptual determining conditions could be found for everything that happens:

> We even expect from the future that these analyses will be constituted of entirely clear and definitely perceptual (*greifbaren*) chemical, physical and structural elements, and that within the analysis there will not be found even the slightest appearance of the teleological view-point.[17]

37. But later Driesch became convinced that by such a descriptive or static theory the autonomy of life processes is not demonstrated, and he thereupon turned to an active or dynamic vitalism, in which the vitalistic agent alters the physical processes occurring. The steps by which his opinion on this matter became changed are fully and explicitly set forth in the paper on "Die Maschinentheorie des Lebens" (1896) and that on "Die Lokalisation morphogenetischer Vorgänge" (1899). In the former paper he remarks that in his earlier theoretical papers, "I saw the specifically biological feature of organic processes in a *given* order or structure, as I called it; in something 'static'; biology was for me in this sense tectonics."[18] In the latter paper, after stating this point again, he remarks, "I hardly need to emphasize the fact that I have now abandoned this standpoint"

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[17] Translation from "Analytische Theorie der Organischen Entwicklung," 1894, p. 149.

[18] "Die Maschinentheorie des Lebens," *Biol. Centralbl.*, 16 (1896), p. 363.

(p. 36); he insists on the need, if vitalism is to be demonstrated, of showing that a vitalistic agent is at work at *particular steps* of the occurrences. In a general theoretical paper of 1902 he says, ''But such a descriptive teleology as I have myself formerly held has nothing to do with the assertion of real autonomy of the life processes.''[19] This distinction between static and dynamic theories has been maintained by Driesch ever since; it is emphasized in ''The Science and Philosophy of the Organism'' (II, p. 136, etc.), static teleological[20] theories not leading to vitalism, while dynamic theories do so.

> The true problem is: *by what single acts* does the restoration of "equilibrium" take place here, especially in those cases in which it is proved that entelechy is at work, and that physicochemical diversities and potentials are not able to offer a sufficient explanation of what happens.[21]

Driesch answers this question by holding that a non-perceptual vitalistic agent may actively intervene at certain steps in the processes, altering what would otherwise occur. The method by which this agent operates we shall take up in a moment.

38. Now, it results from the occasional[22] active intervention of such a non-perceptual agent that the same physical combination may give sometimes one physical result, sometimes another, depending upon whether, and

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[19] ''Zwei Beweise für die Autonomie von Lebensvorgängen,'' Separatabdruck aus: Verhdlg. des V. Internat. Zool. Congress, p. 2.

[20] It is to be noted that Driesch's vitalistic doctrines are throughout teleological; it is only the difference between ''static'' and ''dynamic'' that determines whether a given one of these doctrines asserts ''a real autonomy of the life processes.''

[21] ''Science and Philosophy of the Organism,'' II, p. 177.

[22] Driesch does not hold that this agent is active in all the processes in organisms—so that it is by no means a mere name for the aggregate or unity or consequence of the physical conditions present. ''We know already that not every event that takes place during morphogenesis and metabolism is the direct outcome of entelechian acts'' (''Science and Philosophy of the Organism,'' II, p. 150). He does to death ''any theory which tries to make entelechy arise as a new elemental consequence of some constellation'' of physical conditions: ''entelechy can not be regarded as arising from material conditions of any sort'' (*ibid.*, p. 254).

how, the non-perceptual agent takes part in the process. This being so, it would evidently be impossible from a complete knowledge of all the physical or perceptual conditions to predict what would result from a given situation, even after one had once experienced it. In a previous paper,[23] I have characterized as experimental indeterminism this condition of affairs, in which, in the words of Driesch "Two systems absolutely identical in every physico-chemical respect, may behave differently under absolutely identical conditions, in case that the systems are living systems";[24] and have pointed out that for the work of the investigator experimental indeterminism presents the same practical situation as would absolute indeterminism.

39. It would certainly be difficult to imagine a more fundamental difference, either theoretical or practical, between two divisions of science, than that resulting from the acceptance of experimental indeterminism, along with the determining activity of a non-perceptual agent, for the living; science might well be divided into two contrasted parts, vitalistic and non-vitalistic, on such a basis.[25] Furthermore, as I have already set forth, this appears to me the form to which all vitalistic doctrines come, if they make any really valid distinction in principle between the sciences of the living and the non-living. It is perhaps worthy of note in this connection that the two most influential systems of vitalism at the present time—that of Driesch and that of Bergson—are avowedly such systems of indeterminism, either experimental or absolute.[26]

[23] *Science,* June 16, 1911.

[24] See Jennings, *Science,* October 4, 1912.

[25] Unless indeed it be maintained that such indeterminism holds also for the inorganic—certainly not a widespread doctrine.

[26] Bergson's views are not, like those of Driesch, put in such clear form that it is easy to perceive just wherein the indeterminism lies, or whether the word as he employs it has any precise meaning. Apparently, however, the ground for Bergson's indeterminism is the idea that time makes a change in the action of things, without at the same time necessarily changing the physical substratum of such action. This appears to give the equivalent of experimental indeterminism.

40. The inquiry remains as to the grounds for this proper form of vitalism, based on the active intervention of a non-perceptual agent, and involving experimental indeterminism. Many doctrines of this character appear as mere general reflections, with no attempt at precise formulation of grounds and consequences; to the critic they are intangible. Driesch deserves the gratitude of all students of such matters for working out in full such a doctrine; for showing us whither such a road leads. The complex hierarchy of non-corporeal entities at which Driesch arrives, and which appears so fantastic to some critics, is the logical result of this full working out; persons who hold to the intervention of a non-perceptual agent, but refuse to draw the further consequences of such a doctrine, have no just ground for criticism until they have shown how such intervention can intelligibly produce the results it does without such a system as Driesch sets forth.

41. With the details of that system we shall not deal, but examine only the basis for the fundamental assumption. What ground is there for supposing that situations do occur which involve experimental indeterminism, and consequently the activity of a non-perceptual agent?

42. The concrete grounds which Driesch sets forth may be summarized as follows, taking the argument from development as a type. Driesch holds (1) that in order that what is produced should be determined by physical factors, it can be demonstrated that the egg would have to be a complex machine, with 'typical' diversities in the three directions of space, these diversities being necessary for the production of organisms differentiated in the three directions of space; (2) that a machine with such necessary typical diversities can not be divided in any plane you please and the pieces continue to act as did the whole machine (for the pieces would of course lack some of the necessary typical differentiations). Therefore (3) what the egg produces can not be determined (alone) by physical diversities in

space, but must be determined by the differentiations of some complex, but non-spatial, non-perceptual agent (for, being non-spatial, such an agent is not altered by division, as the physical machine is).

43. The further development of Driesch's system consists in working out logically, with extreme acuteness and subtlety, the characteristics of this complex, non-spatial agent, to which Driesch gives the name entelechy. We may take his conclusions as showing to what doctrines such a view leads. What we are now interested in is this; just where and how would arise situations involving experimental indeterminism?

44. Driesch sets forth that a physical system without entelechy acts differently from the same system with it: "a material system in space left to itself will behave differently from what it would if controlled by entelechy;"[27] "without entelechy there would be other chemical results,"[28] etc.

45. Now, precisely how does entelechy take hold to alter the action that would otherwise occur? So long as a vitalistic theory remains vague and refuses to specify the precise difference between the action if it holds and the action if it does not hold, we lack the essential point for forming a judgment of it. Driesch deserves the highest credit for recognizing this, and refusing to take refuge in vagueness; he attempts to show just how the vitalistic agent may act.

The general condition for anything to happen in the universe is, that uncompensated differences of intensity (of energy, etc.) exist; if two unequal "forces" act against each other, movement occurs in the direction of the greater, etc.

Now, just what entelechy does, according to Driesch, is to compensate some of the existing differences of intensity—thus holding back the action that would occur—and later to release that which was held back. This is said to happen mainly or only "in the spheres of chemical and of aggregative events,"[29] these of course comprising most of what happens within organisms.

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[27] "Science and Philosophy of the Organism," II, p. 336.

[28] *Ibid.*, p. 254.

> But entelechy *is* able, so far as we know from the facts concerned in restitution and adaptation, to *suspend* for as long a period as it wants any one of all the reactions which are *possible* with such compounds as are present, and which would happen without entelechy. And entelechy may *regulate* this suspending of reactions now in one direction and now in another, suspending and permitting possible becoming whenever required for its purposes.[30]

This is the *only* thing that entelechy can do.[31]

46. It requires little thought to perceive how powerful such an agent would be. In a cell containing chemicals *a, b, c, d,* etc., all of which tend to interact, it could allow *a* and *c* to unite, but prevent *a* and *d,* etc. If our four chemicals were H_2SO_4, HCl, NaOH and KOH, such an agent could restrain the union of H_2SO_4 and KOH, and of HCl and NaOH, permitting the rest; as a result we should get a certain set of compounds. Or, if entelechy restrained others, we should get a different set of compounds from the same chemicals. If an organism swallowed poison, or if poison were in any way produced within its tissues, this agent could hold back the action of the poison on the tissues, so that the organism would be unharmed, until it had had time to eliminate these poisons through its excretory apparatus. If one of the two cells of an egg contained all the conditions required for producing both the anterior and the posterior part of the body, such an agent could hold back one set of processes and permit the other, thus deciding which part of the body should be produced. Or if the egg contained all conditions necessary for producing both a starfish and a sea urchin, such an agent could in this way decide which animal should be produced. If an organism contained the conditions necessary for producing

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[29] *L. c.*, p. 181.

[30] *L. c.*, p. 180.

[31] *L. c.*, pp. 178, 180, 185, 187, etc.

any of the actions of which men are capable, this agent could determine which actions would occur.

47. In such suspension of action entelechy transforms kinetic energy into potential energy; stopping a movement, the energy of the latter becomes potential (instead of being dissipated as heat, as is usual in stoppages that occur through other agencies). Later the movement can continue again, the potential energy being reconverted into kinetic.[32] Thus there is no offense to the principle of the conservation of energy; this is the reason why the action of entelechy is to be conceived in this precise way. Driesch takes up the case of a moving element having a mass *m*, and shows just how the process would work; the kinetic energy "is transformed into an equivalent amount of 'potential' energy located at the place of *m* and kept there till it is set free, that is, transformed into kinetic energy"[33] again.

48. Now, this portrays clearly the situation that involves experimental indeterminism. Consider this mass *m*, moving at a certain speed. It is stopped in a certain position by entelechy; its kinetic energy is converted into potential. Another body of the same mass lies in the same relative position; it has not been stopped by entelechy. The two masses are alike in all respects, but one contains a great amount of potential energy, the other none. There is no way of calculating from the position and the mass the amount of energy contained. If we studied one and determined its potential energy experimentally, we could tell nothing as to the potential energy of the other, though the two were perceptually alike in all respects. One would lie quiet; the other, on being released by entelechy, would proceed on its way with all the energy that it had before possessed.

This situation would be striking in the case of chemical reactions. Two substances, *a* and *b*, are in juxtaposition, under given external conditions. They do not unite, being restrained by entelechy. Again, the same two substances are in juxtaposition, under the same conditions. This time they do unite, not being restrained by entelechy. If we have several chemicals in juxtaposition, the variety of results obtainable as a result of selective suspension by entelechy would be very great. By studying what happens under given conditions in one or several cases, one could discover no rule that would hold, as to what would happen under the same conditions in another case.

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[32] *L. c.*, pp. 219–221.

[33] *L. c.*, p. 220.

49. It is evident that the conditions set forth by Driesch for the operation of entelechy are present in every organism, and in every cell of every organism. Thus if the experimenter on organisms reaches different results in different cases, he may be quite on the wrong track in searching for some perceptual difference in the two cases; the diversity of results may be due to the diverse operation of entelechy on perceptually identical systems. This Driesch fully recognizes, as the quotation given in section 38 shows; other statements to the same effect, such as: "I reject absolute indeterminism, but accept experimental indeterminism," are quoted in a former paper.[34]

50. It will be observed that the acceptance of experimental indeterminism is a necessary consequence of the exposition of the work of entelechy given in the "Science and Philosophy of the Organism." But apparently this is an undesigned consequence; what the author attempted to establish is the activity of the non-perceptual agent, and he is merely compelled to accept experimental indeterminism into the bargain, apparently with some reluctance. He has not, so far as I know, touched in his published works upon the difficulty for experimentation induced by this condition of affairs.[35] He now,

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[34] *Science,* October 4, 1912.

[35] The quotations from Driesch on experimental indeterminism given in this and former papers are from letters, and are published with his permission. (But see note at end of this paper.)

as Lovejoy has recently set forth,[36] endeavors to minimize the difficulties presented to the experimenter by this condition of affairs, holding that "practically experimental indeterminism is not a great danger for science."

51. Certainly such a conclusion can not be deduced from the arguments advanced by Driesch while endeavoring to establish the activity of his non-perceptual agent. "Chemical and aggregative events," which he holds to be the sphere of operation of entelechy, comprise most of the events taking place in organisms, and if "entelechy is able . . . to suspend for as long a period as it wants any one of all the reactions which are possible with such compounds as are present, and which would happen without entelechy," etc., no experiment in biology fails to present the conditions for the interference of entelechy. Hence the experimenter must always be in doubt as to whether it is worth while to search for preceding perceptual differences determining different results in two experiments. Just so far as it does present such difficulties for experimentation, and no farther, is there basis for such a determining activity of a non-perceptual agent as set forth in Driesch's vitalism.

52. But is there reason to believe that if we could actually perceive all potentially perceptual diversities, we should really ever find that two systems identical in all perceptual factors behave differently? To me it appears that there is none; and that, so far as development goes, it can be asserted that for every case cited in support of vitalism in which diversities of development arise, definite preceding perceptual diversities can be pointed out, which experimentally determine the later diversities. I question whether any one would attempt to cite a case in which this can not be done. If this be the state of the case throughout, then empirical demonstration of experimental indeterminism is impossible, for no case of it ever arises.

53. If this be true, it seems important for forming a

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[36] *Science,* November 15, 1912.

judgment of the validity of this sort of vitalism. Now, it appears to me that in his recent attempt to show that such vitalism does not seriously affect experimental science—in the letter quoted by Lovejoy—*Driesch in effect admits this; pulls the empirical foundations from beneath his theory,* so far as they depend on the occurrence of any particular cases in which two perceptually similar systems behave differently, and is left in the position of maintaining in general what he denies for all particular cases; at least he saves himself from this position only by the expedient of asserting the "very great probability" of certain conclusions, in place of their certainty. The passage lends itself so fully to the arguments of those convinced that any doctrine involving experimental indeterminism has no sound basis that I should have hesitated to make use of it until similar statements were incorporated into some formal publication by Driesch, save for the fact that, with Driesch's permission, it has already been given currency by Lovejoy.[37] The passage is as follows:

> Practically, we may say that complete knowledge of the physico-chemical constitution of a given egg in a given state and of the behavior following this constitution in one case implies the same knowledge for other cases (among the same species) with a very great probability. But this is a probability *in principle* and can never be more. It would not even be a probability in the case that we did not know the origin (or history) of the "given egg in a given state," viz.: that this egg is the egg, say, of an ascidian. But to know this "history" or "origin" *is, of course, already more than simply to know* "the physico-chemical constitution" and its consequences in one case (which suffices in the realm of the inorganic).
>
> It *may* be that the eggs of fishes, echinoids and birds are the same in all *essentials* of the physico-chemical constitution. There happens something very different in the different cases on account of the different "entelechies."
>
> In spite of this; we know what will happen with great probability from one case, if you know that this egg "comes from a bird" and that the other "comes from an Echinoid." (I, intentionally, leave out of account here the existing differences in size, shape, etc., of the eggs in question; these *may* be *not* among the "essentials.")

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[37] *Science,* November 15, 1912. (See note at end of the present paper.)

Therefore: *practically* "experimental indeterminism" is not a great danger for science.

54. There are here two main points that are of interest in the present connection.

(1) In the case of comparing eggs *from the same organism,* evidently the situation resulting in experimental indeterminism never arises so far as the "very great probability" is realized. Thus the differences in the development of different cells of the sea urchin egg, or of fragments of *Tubularia,* or of the ascidian, on which Driesch bases so largely his vitalism, are all due experimentally to perceptual differences in the conditions, so that so far as experimental explanation goes, they are accounted for in the same sense that any diversity of action is accounted for in the inorganic world.

The only escape from this lies in Driesch's substitution of "very great probability" for *certainty.* The special grounds for this substitution are not evident. Even with regard to inorganic events, no man can say absolutely that what has happened under given conditions will "certainly" always happen under the same conditions; for the only test of this is experience, and some cases are not yet experienced. But no distinction along this line between organic and inorganic is evident, when once a "very great probability" is admitted for the organic.[38]

Those who begin by assuming intervention by a nonperceptual agent might argue that under the same conditions throughout, the purposes of entelechy would always be the same, hence it would always cause the same things to be done under the same conditions. But this is merely another way of admitting that no cases showing experimental indeterminism ever occur.

(2) With regard to eggs from diverse organisms there are two main points:

(*a*) The distinction made between knowing the history or origin, and knowing the physico-chemical constitution signifies the following experimental situation. If an experimenter could have the egg of a starfish and another of a sea urchin presented to him, knowing nothing of their origin, could examine each so thoroughly as to perceive all the perceptual characters, all the physical diversities well known to exist between the two, and could observe that one develops into a starfish, the other into a sea urchin—*he could not predict, when a similar pair are again presented, which would produce a starfish. which a sea urchin* (although it is admitted that he could if he knew the origin of the two). Is there any plausible ground for such a proposition?

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[38] But see note at the end of this paper.

(*b*) As between these eggs from different organisms, the assertion is that the diversities in what occurs are not due to the present and observable differences in physical constitution, these differences being supposedly "not among the essentials."

Now, this abandons experimental evidence and *all possibility of such,* for it is well known that the eggs of different organisms do show differences in constitution, and that these differences are followed regularly by differences in what happens, which is all that experimental science can discover.

55. The result of these two admissions is then to leave without any possible empirical basis the idea that two perceptually identical systems can give diverse results, save only if there are ever cases with eggs of the same organism where the "very great probability" spoken of is not realized. All admit that the eggs of diverse organisms *are* perceptually diverse; Driesch admits that the eggs of the same organism always do the same thing under the same conditions "with very great probability." Nothing then is left, so far as development is concerned, but the substitution of this "very great probability" for "certainty," as a basis for the idea that an experimental, perceptual, cause is ever lacking for any diversities in result; and so for that kind of vitalism which requires and depends upon experimental indeterminism.

SUMMARY

In conclusion, the point of view developed in the foregoing may be briefly characterized and compared with that presented in certain other discussions. It agrees, I take it, with Lovejoy, Spaulding, and others, in admitting the possible validity of a "vitalism" that makes no distinction between the science of the living and that of the non-living, holding merely that mechanistic formulation is not adequate to nature in general; such "vitalism" being synonymous with "energetics" or "temporalism," or some similar doctrine. Confusion of such a doctrine with a vitalism that holds to a deep-lying distinction between the science of the living and that of the non-living is a common source of misunderstanding.

As to doctrines which attempt to make such a deep lying distinction, dividing science into two contrasted kinds, vitalistic and non-vitalistic, it farther admits (with, I judge, Lovejoy, Bergson, Woodruff, Ritter, Spaulding, Glaser and others) that configurations perhaps exist in the living, whose laws of action are not predictable from a formulation of what happens in configurations occurring in the non-living. But this is held to be merely an example of a general principle, equally well exemplified when diverse inorganic configurations are compared: from formulating the action of one configuration, that of another can not be predicted with certainty, until its action has also been experienced; this continual recourse to observation and experiment being one of the essential features of science in general. Hence it holds that such facts present no ground for dividing science into two divisions, vitalistic and non-vitalistic; but also that study of the organic configurations of matter gives results that are as fundamental as the study of inorganic configurations; results which no exclusive study of the latter could ever supply. Parts of biology are therefore "antonomous" in the same sense, and in no other sense, that the science of the compounds of carbon is autonomous in comparison with that of the compounds of copper.

It thus holds, in agreement with Driesch, that any "static" doctrine, in which admittedly the perceptual conditions determine what happens in the living system, does not make a difference in principle between the laws of the living and those of the non-living; but that to make such a difference, it must be held that the *same conditions* may act diversely in the two fields; thus giving rise to experimental indeterminism (and perhaps to the assumption of a non-perceptual factor for determining the diversities not otherwise accounted for, as in the vitalism of Driesch). But it holds (I take it with Lovejoy, Glaser, Woodruff, Spaulding, Sumner and perhaps most investigators) that we do not have grounds for supposing that such a condition exists; and that even Driesch's presentation results in the non-existence of any actual cases of experimental indeterminism.

Note.—Since this paper was written Driesch has published an article ("Ueber die Bestimmtheit und die Voraussagbarkeit des Naturwerdens," *Logos,* Bd. 4, 1913, pp. 62–84) in which he (1) states clearly his acceptance of experimental indeterminism for the organic (p. 65); and (2) attempts to show that the grounds for substituting *very great probability* in place of *certainty* are stronger for the living than for the non-living. The argument on this second point is a somewhat abstruse one, based on certain consequences held to flow from the concept of individuality.

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